BNL-82143-2009-AB

QUANTIFYING THE ROLE OF CCN AND GIANT NUCLEI IN WARM RAIN

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For presentation at the
Atmospheric Radiation Measurement (ARM) Program
Science Team Meeting,
Louisville, KY
March 30-April 3, 2009

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ABSTRACT

Homogeneous nucleation theory forms the foundation for a new theoretical model of drizzle formation in warm clouds: the kinetic potential (KP) theory of drizzle formation [McGraw and Liu, Phys. Rev. E 70, 031606 (2004)]. Key cloud properties entering the KP theory are droplet number concentration, liquid water fraction, and a parameterized turbulence, from which are predicted a well-defined critical droplet size, defined by the condition that the rate of droplet growth by condensation and collection is balanced by evaporation, a nucleation barrier height, and a barrier crossing rate, which is identified with the drizzle rate. In this presentation the KP theory is unified with aspects of Kohler theory to provide a quantitative description of effects of CCN and giant nuclei on drizzle rate. It is found that giant nuclei (particles in the 1-10 micron range) act to lower the barrier and thereby increase rate in a way similar to a heterogeneous nucleation process. The extended KP theory should provide a quantitative framework for analysis and testing through comparisons with cloud and precipitation measurements.
